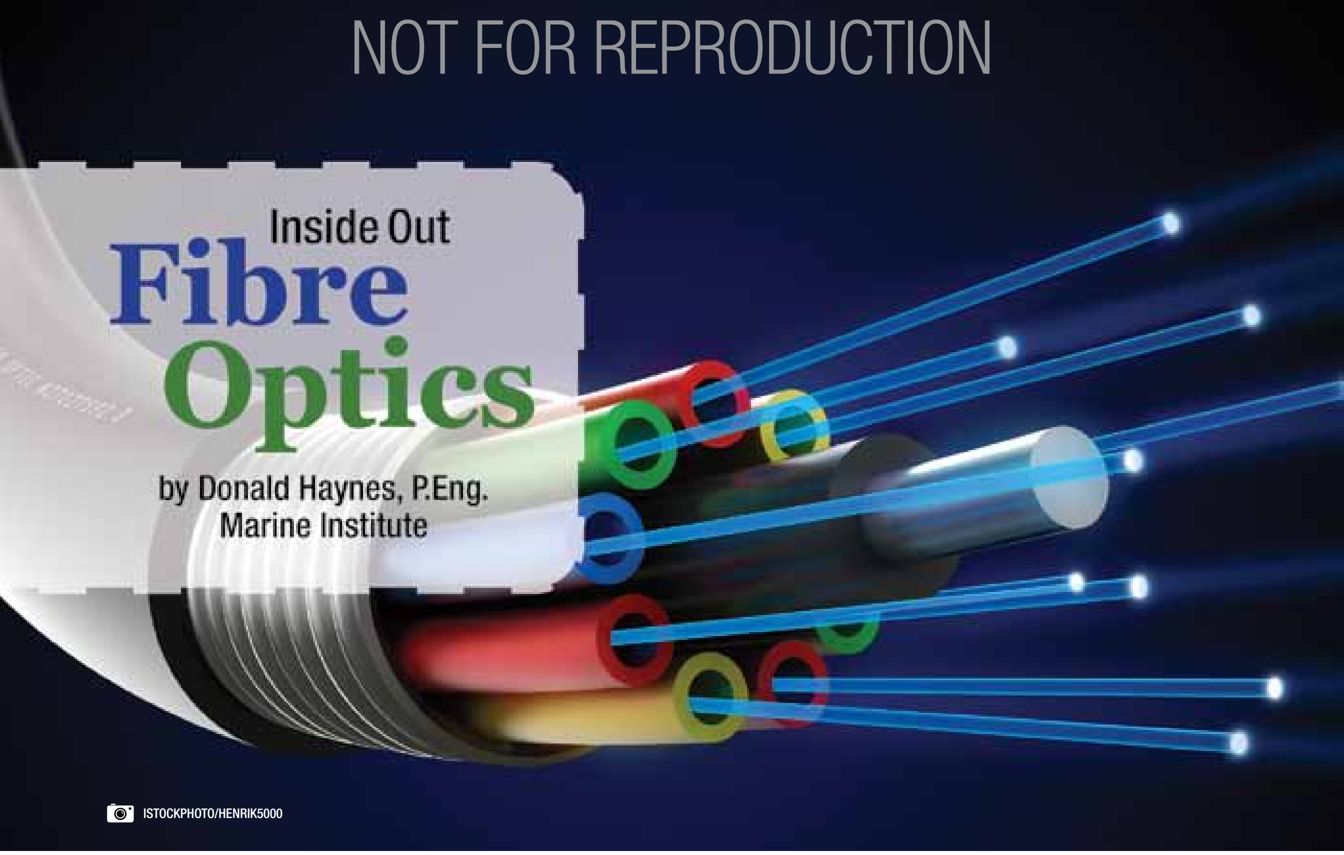

Inside Out
Fibre Optics

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As ROVs are used to deploy an increasingly complex and bandwidth-hungry array of sensors, manufacturers are increasingly turning to fibre optic technology to transmit signals and data to and from the vehicle.

Fibre optic systems are based on the principles of refraction and reflection of light. They use transceivers positioned at each end of a pair of glass fibres. The transceivers include light emitting devices, such as laser diodes, that convert modulated electrical signals to light rays with wavelengths in the infrared region and beyond. These light rays carry information along a thin strand of glass fibre that is roughly the diameter of a single strand of human hair, with bandwidths up to 10 Gbit/second. To detect the signal, the transceivers use photo diodes that collect the light and convert it back to its electrical counterpart.

Glass fibres are actually glass-in-glass structures, consisting of a solid glass core encapsulated by and fused to a separate glass outer shell, or cladding. A plastic buffer coating is placed on top of the cladding to protect against moisture and fractures. A cross-section of a typical glass fibre is illustrated below. When light is launched into the fibre core, it first transcends the interface between the emitting diode lens and the end of the fibre. In this transition, the light experiences a change in direction in response to a change in its speed, a phenomenon known as refraction. The amount of refraction is influenced by the specific wavelength of the light and the index of refraction of the medium.

The index of refraction is a way of measuring the speed of light in a material. Light travels fastest in a vacuum (about 300,000 kilometres per second). The larger the index of refraction, the slower light travels in that medium.

As light travels along the fibre core it encounters the core-cladding boundary. To confine the optical signal in the core, the fibre is designed such that the refractive index of the core is greater than that of the cladding. This ensures that the light is reflected back into the core, guiding and reflecting it along without any appreciable signal loss. In this way, the core acts as waveguide, or 'light pipe.' Typically, ROV tethers are manufactured with single-mode step index or multi-mode graded index fibres. In step index fibres, the core-cladding boundary is abrupt and rays of light are guided along the fibre core by total internal reflection. In graded index fibres, the index of refraction in the core decreases continuously between the axis and the cladding. This causes the light rays to bend smoothly as they approach the cladding, rather than reflecting abruptly from the core-cladding boundary. Multi-mode fibre has a larger core diameter, which means that it is better at collecting light and therefore less expensive to manufacture. But the transmission distance over multi-mode fibre is generally limited to two kilometers or less, precluding its use for deep water applications.